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Use of a Blended Satellite and *in situ* Sea Surface Temperature Climate Data Record for Evaluating Long-term Impacts on Coral and Marine Mammal Communities

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Introduction

The NOAA ¼° daily optimum interpolation (DOI) sea surface temperature (SST) dataset, described in Banzon et al. (2016):

- has a ¼° (~25 km) spatial resolution suitable for examining mesoscale or greater, and
- has a temporal resolution (1-day) that allows study of processes that are affected by temperature variations on a daily or greater scale.

DOISST was selected by the Climate Data Records program (Bates et al., in press) as a consistent and sufficiently long satellite-based record to detect long term trends and examine climate-related processes.

This foundational dataset has broad applicability, as demonstrated by three use cases shown here.

1 Coral Bleaching Heat Stress

Fig. 1. Bleached plate corals and live sea fans on Molasses Reef, Key Largo, Florida. Photo courtesy of Matt Keiffer (Picasa).

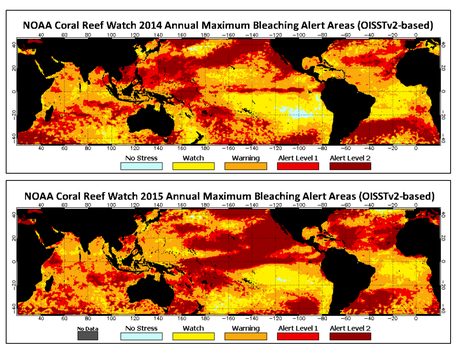


Fig. 2. A global bleaching event caused by thermal stress started in 2014 and has continued into 2015 and 2016.

Heat stress is conducive to coral bleaching (Fig. 1). An ongoing global bleaching event is in its third year (Fig. 2). Has heat stress increased as a result of the recent climate change?

NOAA Coral Reef Watch (CRW) examined the 34 years of DOISST data for answers, based on the algorithm used in CRW's near-real-time satellite bleaching heat stress monitoring (Liu et al., 2014).

Significant increase in severe stress is seen not only in the intensity (Fig. 3) but also spatial coverage (Fig. 4).

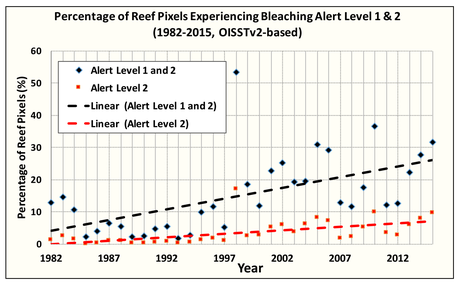


Fig. 3. Time series of the 1982–2015 annual percentage of (¼)° reef pixels experiencing severe heat stress levels (Alert Level 1 and 2) and the associated trends.

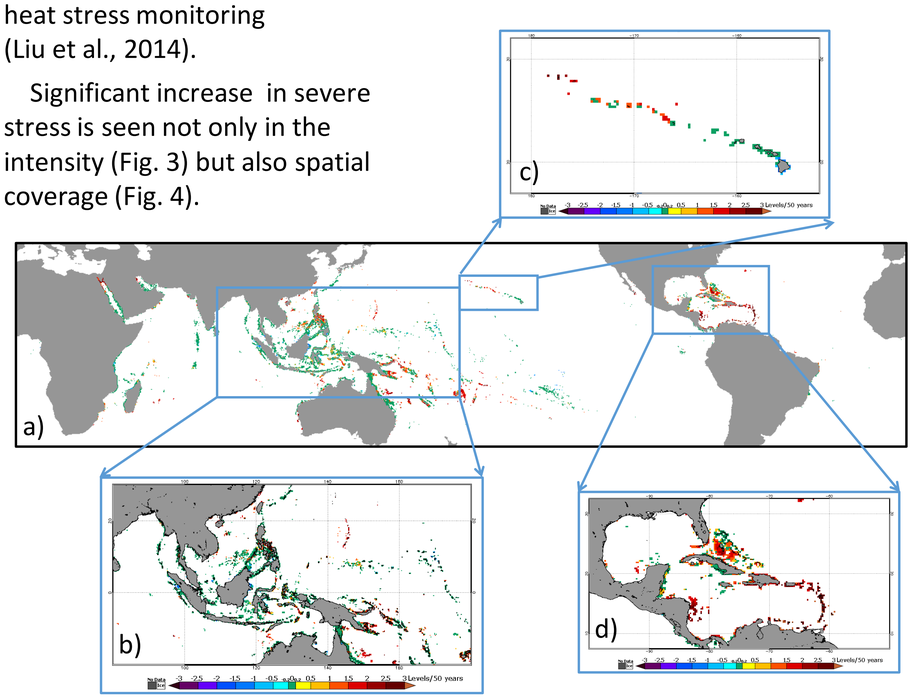


Fig. 4. Trend of 1982–2014 annual maximum coral bleaching heat stress level at reef locations (a) globally, (b) the Coral Triangle, (c) Hawaiian Island chain, (d) the Caribbean [Green pixels: small (-0.2, 0.2) or insignificant (P>0.1) trends].

2 Marine Mammal Management

DOISST has been used successfully in habitat-based models of the distribution and abundance of cetaceans (whales, dolphins, and porpoises) in both the central and northeastern Pacific (Fig, 5–7). For many species, SST serves as an effective proxy for unmeasured underlying ecological processes linking cetaceans to their prey.

Using DOISST, the models successfully captured variability in cetacean distribution at seasonal and interannual time scales. Such models can provide a foundation for dynamic ocean management, especially in the face of long term temperature change.

Bryde's whale
Balaenoptera edeni
Central North Pacific

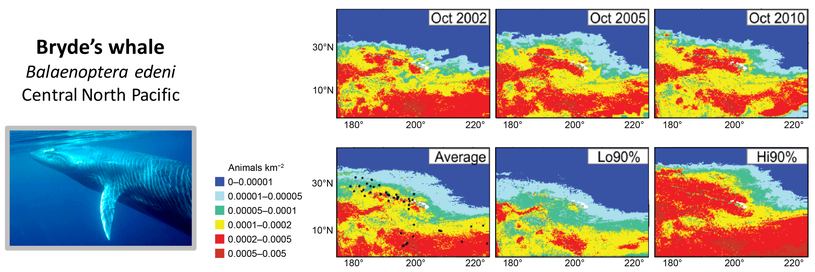


Fig. 5. Model-based estimates of density (animals km^{-2}) and distribution for the tropical Bryde's whale showing variability in the central North Pacific. Top three panels show predictions, and bottom panels show multi-year average density and confidence intervals. (*Forney et al. 2015*)

Short-beaked common dolphin
Delphinus delphis
California Current

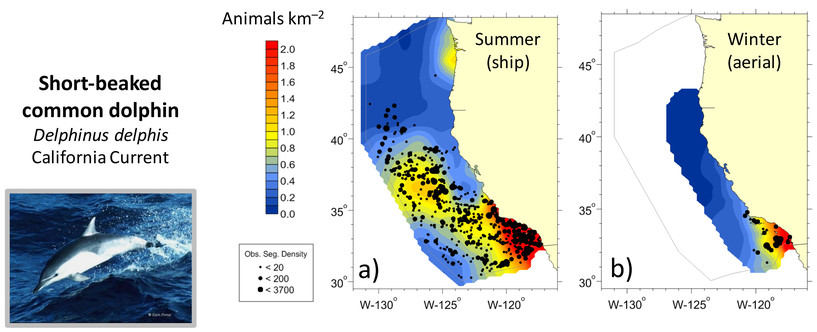
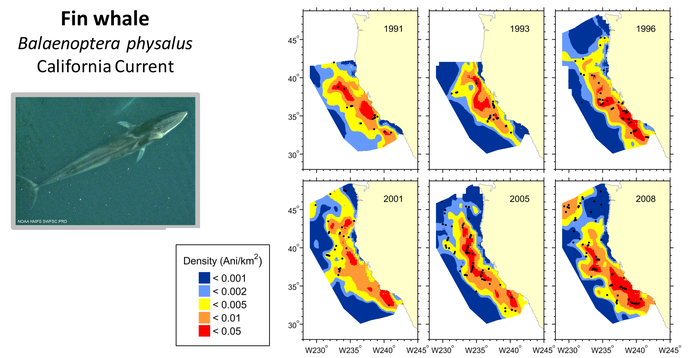


Fig. 6. Densities of animals km^{-2} (a) from summer models built using DOISST and (b) the resulting winter predictions. Black dots show actual sighting locations from summer ship surveys (a) and aerial surveys that covered a smaller study area (b). Larger sighting dots indicate more animals. (*Becker et al. 2014*)

Fin whale
Balaenoptera physalus
California Current



Dall's porpoise
Phocoenoides dalli
California Current

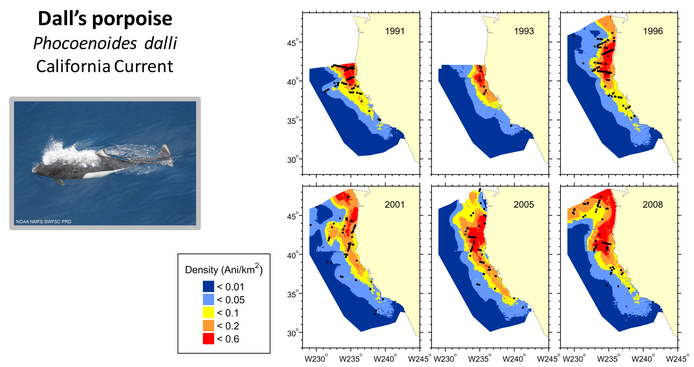


Fig. 7. Interannual variability of cetacean distribution. Model-based estimates of summer/fall density (animals km^{-2}) and distribution for six different years, 1991–2008. Black dots are actual sighting locations during ship surveys conducted in each year. Model details: *Becker et al. (In press).*

3 Future SST Projections

The fifth phase of the Coupled Model Intercomparison Project (CMIP5) provides estimates of future SSTs (Taylor et al. 2012) under different scenarios (called representative concentration pathways or RCPs; Van Vuuren et al., 2011). Simulations of the historic period are also done to compare model performance against current observations.

For RCP6.0 (medium stabilization scenario), average SST could increase up to ~7 °C by the end of this century (Fig. 8). To match the higher resolution required by ecological applications, model SSTs can be "adjusted" using the difference between model SSTs and DOISST for a common period (e.g., 1982–2011, Fig. 9).

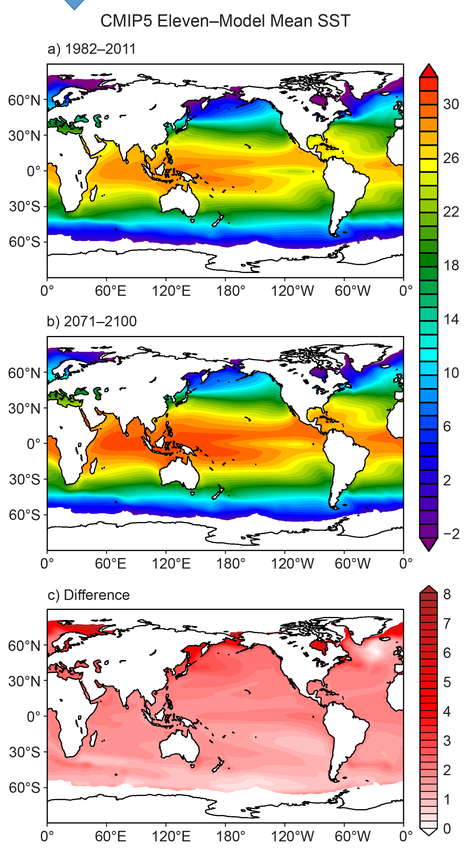


Fig. 8. Model SSTs in °C for (a) CMIP5 historical run for the period 1982–2011, (b) CMIP5 RCP6.0 simulations of the end of 21st century and (c) the magnitude of the temperature increase.

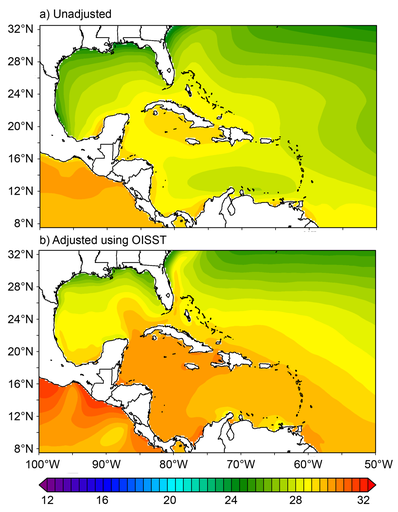


Fig. 9. Caribbean region projected SSTs for 2071–2100 from (a) CMIP5 RCP6.0 (11-Model Mean); (b) adjusted using CMIP5 historical minus DOISST has better defined ocean features.

References

Banzon, V., et al., 2016: Along term record of blended satellite and in situ sea surface temperature for climate monitoring, modeling and environmental studies. *Earth System Science Data Discuss.*, doi10.5194/essd-2015-44, in review.

Bates, J.J. et al., 2015: Sustained production of multidecadal climate records - Lessons from the NOAA Climate Data Record Program. *Bull. Amer. Meteor. Soc.*, e-View, doi:10.1175/BAMS-D-15-00015.1.

Becker, E.A., et al., 2014: Predicting seasonal density patterns of California cetaceans based on habitat models. *Endang Species Res*, **23**, 1–22, doi:10.3354/esr00548.

Becker, E.A., et al., (In press): Moving towards dynamic ocean management: How well do modeled ocean products predict species distributions? *Remote Sens.*

Forney, K.A., et al., 2015: Habitat-based models of cetacean density and distribution in the central North Pacific. *Endang Species Res*, **27**, 1–20, doi:10.3354/esr00632.

Liu, G., et al., 2014: Reef-scale thermal stress monitoring of coral ecosystems: New 5-km global products from NOAA Coral Reef Watch. *Remote Sens*, **6**, 11579–11606, doi:10.3390/rs61111579.

Taylor, K.E., et al., 2012: An overview of CMIP5 and the experiment design. *Bull Amer Meteor Soc*, **93**, 485–498, doi:10.1175/BAMS-D-11-00094.1.

Van Vuuren, D.P. et al., 2011: The representative concentration pathways: An overview. *Climatic Change*, **109**, 5–31, doi: 10.1007/s10584-011-0148-z.